ERDC TN-DOER-C20
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Implementation Guidance for the Control of Undesirable Vegetation on Dredged Material

PURPOSE: The purpose of this technical note is to provide guidance for implementing selected management practices to control undesirable vegetation on dredged material.

BACKGROUND: Dredged material is normally removed from navigable waterways or from aquatic environments and placed in confined disposal facilities (CDFs) or in other upland environments. Natural colonization is allowed, although in many cases undesirable vegetation such as *Phragmites communis* (common reed), *Salix* sp. (willow), *Populus* sp. (poplar and cottonwood), *Bidens bipinnata* (Spanish needle), and/or *Pennisetum purpureum* (napier grass) becomes established. Recently, CDFs have filled, and new CDFs are extremely difficult to find. Removal and beneficial use of dredged material are becoming more desirable to provide storage space for future dredged material. However, undesirable vegetation has interfered with CDF operations and the potential beneficial use of dredged material as a high-quality material. Elimination of undesirable vegetation will enhance the quality of the dredged material for use in beneficial products such as manufactured topsoil, engineered soil capping material, building blocks, and construction flowable fill. Under the Dredging Operations and Environmental Research program, demonstration projects were conducted to develop management strategies to control undesirable weedy vegetation on dredged material.

INTRODUCTION: When dredged material is placed in a CDF and/or an upland environment to construct dikes or levees, various management strategies are used ranging from no management to different degrees of management. No management normally results in a wide variety of aggressive vegetation colonizing the site. In many areas, the vegetation that will establish is common reed or Phragmites (Figure 1), willow, poplar, and cottonwood as well as any weeds that might exist in the adjacent surroundings (Figure 2).

There are many approaches to controlling undesirable weedy vegetation for various situations: selective herbicide spraying, mowing, fire, and/or tillage. In some cases improper mowing of vegetation has actually resulted in increased amounts of undesirable vegetation. In these cases, mowing was too close to the ground, eliminating desirable vegetation such as *Paspalum notatum* (Bahia grass) and allowing undesirable vegetation such as napier grass to become established (Figure 3). Selective herbicide sprays have been used successfully for specific locations. Tillage is used in agriculture in combination with selective herbicides. Fire is used in certain situations to control undesired vegetation. Fertilization and soil management have been used in combination with mowing. In situations where spraying, fire, and tillage are not permitted, the wiping of selective herbicides can be more appropriate and effective in combination with minimum mowing.

This technical note describes an innovative management strategy for maintaining desirable vegetation while controlling undesirable weedy vegetation on dredged material where use of some weed controls such as fire, herbicide spraying, and tillage is not allowed or practical. Two examples of

demonstrations of this strategy will be discussed: Herbert Hoover Dike, Lake Okeechobee, FL, and Eagle Island CDF, Wilmington, NC.

METHODS: An innovative technology for wiping herbicides was identified from participation in the National Roadside Vegetation Management Association (NRVMA) annual conferences. Exhibits of new equipment and techniques were presented at annual conferences in 1995 and 1996. A wiper applicator was displayed by Cross Equipment Company, Inc. (CECI), Sebring, FL, at the 1995 annual NRVMA conference in New Orleans, LA, and at the 1996 annual conference in Minneapolis, MN. Mr. Dana Ritenour, CECI, described the effectiveness of the wiper applicator and agreed to demonstrate the use of the wiper to control undesirable weedy vegetation on dredged material at Corps projects in cooperation with the U.S. Army Engineer Research and Development Center (ERDC).

Lake Okeechobee, FL. The first demonstration was at Lake Okeechobee on the Herbert Hoover Dike, which was constructed with dredged material removed from Lake Okeechobee in the1970's to establish an inner rim canal. The dredged material was predominantly sand and marl with a soil pH of 8.5. Contractors for the U.S. Army Engineer District, Jacksonville, had been fertilizing and mowing vegetation on the approximately 282-km- (175-mile-) long dike system for a number of years. Mowers had cut the desirable vegetation Bahia grass and *Cynodon dactylon* (Bermuda grass) extremely short, below 25.4 mm (1 in.), resulting in suppressed regrowth of these species. Undesirable vegetation such as napier grass and Spanish needle had become established on large areas of the dike (Figure 3). High levels of fertilizer were applied for maximum growth of Bahia grass when the presence of that species was extensively reduced. Consequently, the undesirable vegetation continued to grow and spread to even larger areas of the dike. Management of vegetation was changed in 1995, after ERDC was asked to assist the Jacksonville District to reduce fertilizer applications and provide guidance and demonstration of innovative technologies in vegetation management on dikes and levees constructed from dredged material. The Florida State Water Management Districts were requiring all nutrient inputs to Lake Okeechobee to be reduced. The loading of nitrogen and phosphorus was required to be reduced to control nutrient-related eutrophication in Lake Okeechobee and to improve the water quality of the lake under the South Florida Ecosystem Restoration Program.

Soil samples were collected for each mile of the Herbert Hoover dike from each side of the dike for the entire dike system. The soil samples were sent to the University of Florida at Gainesville for soil fertility testing. Minimum fertilizer for the maintenance of desired vegetation was recommended based on the soil test results. These fertilizer rates were applied to the dike. In addition to reduction of applied commercial fertilizer being evaluated, other ways to improve soil fertility using available residual materials and management of vegetation were considered. The application of recycled soil manufacturing technology (RSMT) and the use of plant species such as perennial peanut (*Arachis glabrata Benth.* cultivar Florigraze) that required less fertilizer and mowing were also evaluated in the demonstration. Demonstration plots were established using RSMT by incorporating cellulose in the form of yardwaste (Figure 4), bagasse (Figure 5), melaleuca compost (Figure 6) and lake debris (Figures 7 and 8) in combination with biosolids such as N-Viro Soil® (reconditioned sewage sludge) and BionSoil® (reconditioned animal manure). These plots improved the soil fertility substantially but also increased the growth and amount of undesirable weeds whose seed had accumulated in the dike soil over the years (Figure 9). Consequently, weed control was required on

all demonstration plots. The bagasse and N-Viro biosolids plots showed the least amount of undesirable vegetation and the best growth of planted desirable vegetation (Figure 10). After 2 years of herbicide wiping, Spanish needle continued to reestablish from the massive seed bank collected over the years (Figures 11 and 12). However, perennial peanut became established on the bagasse and N-Viro plots despite the continuous regrowth of Spanish needle (Figure 13).

Vegetation management changes in mowing height for the entire dike system were implemented in 1995. Mowing height was increased to 152-203 mm (6-8 in.) above the ground, which allowed the desired grass to compete more effectively with undesired weedy vegetation. Innovative technologies were applied to control the undesirable vegetation. A weed wiper applicator (Figure 14) was used to control the taller undesirable napier grass and Spanish needle. The glyphosate herbicide Round-Up® was applied at a rate of 2.3×10^2 mℓ/ha (32 oz/acre) as full-strength liquid to the wiper that was set at 305 mm (12 in.) above the ground at a tractor speed of 4.8 km/hr (3 miles/hr) (Figure 15). Round-Up® is registered by the U.S. Environmental Protection Agency for use in noncrop sites to control undesirable grasses.

The initial wiper was constructed of an aluminum panel measuring 102 mm by 203 mm by 3 m (4 in. by 8 in. by 10 ft) long covered with coarse sand grit comparable to coarse sandpaper. The herbicide was applied to the gritted surface by plastic tubes and micropumps. The panel became wet with herbicide. As the wiper came into contact with the undesirable plant leaf, the grit surface scratched the leaf surface and applied herbicide in the wound. The herbicide entered the plant leaf immediately and was translocated to the plant root, resulting in total plant kill. This innovative technique can be used when herbicide spraying cannot be used because of windy conditions or other adverse weather conditions. The wiper technique used approximately one-quarter of the herbicide used by typical sprayers to kill undesirable vegetation and does not injure nontarget (desirable) vegetation that might come in contact with spray drift.

The wiper applicator was improved by covering the aluminum panel with an Astroturf™ type carpet material. Plant leaves are chafed by the brace chains ahead of the panels and scraped by the Astroturf™ carpet material. The improved panel works as well as the grit panel and provides for more even distribution of herbicide solution through a series of check valves installed to prevent gravitational flow within the panel while working at acute angles on the side of the levee. Additional improvements were made by applying a 7.01×10^3 mℓ/ha (96-oz/acre) solution of glyphosate chemical and water. Mixing rates have been 9.46×10^2 mℓ (32 oz) chemical/18.92×10^2 mℓ (64 oz) of water or 710 mℓ (24 oz) chemical/2,129 mℓ (72 oz) of water. The water reduces the viscosity of the herbicide, thus making it easier for the plant to absorb and translocate. The diluted herbicide solution also disperses on the plants better than the pure chemical.

In areas of predominately napier grass, four wipings (Figures 16 and 17) were required to almost eliminate that plant. However, as soon as the napier grass disappeared, Spanish needle covered the area (Figure 18). Two additional wipings of 2.3×10^2 mℓ/ha (32 oz/acre) of Round-Up® herbicide were required to control the Spanish needle vegetation. A combination of wiping and mowing over 2 years was required to control napier grass and Spanish needle vegetation and allow the Bermuda grass and Bahia grass to reestablish on the area. The wiper applicator also successfully controlled undesirable weeds on all of the RSMT demonstration plots established on the dike.

Cost per acre to control napier grass and Spanish needle is estimated over a 2-year period at:

Item	Cost
Herbicide (Round-Up®) 2.3×10^2 mℓ/ha (32 oz/acre) @ \$55/3.8 ℓ (128 oz (1 gal)) (6 times) (or Herbicide (Round-Up® type*) 2.3×10^2 mℓ/ha (32 oz/acre) @ \$36/3.8 ℓ (128 oz (1 gal))	\$ 82.50 54.00)
Application tractor/driver/wiper 0.4 hr/acre @ \$ 50/hr (6 times)	120.00
Grass mowing: 0.16 hr/acre @ \$ 50/hr (3 times)	24.00
	\$226.50 (or \$198.00)
* The generic equal to Round-Up® is Gly-Flow.	

This 2-year cost is approximately equal to the current cost for 2 years of mowing the existing vegetation on the Herbert Hoover Dike system without control of the weeds.

Other equipment has been developed using the same principles of wiping herbicide on plant leaves versus spraying. A demonstration was conducted in 1999 in cooperation with Monsanto/Weedbug, using newer equipment called the Weedbug®. This equipment, developed in Australia, uses nylon rope instead of the grit panel as the carrier for the herbicide. The saturated rope spins around in a disk-shaped applicator, scratches the plant leaves, and puts herbicide in the scratches for a total kill of the plant. The centrifugal force keeps the ropes saturated equally for a uniform distribution of the herbicide. This is an improvement over the wiper panel, since the tubes on the wiper panel can sometimes get clogged and result in uneven distribution of the herbicide application, producing streaking of the missed plants. These areas are usually eliminated in subsequent wipings. A demonstration area was established near Canal Point, FL, with the Weedbug® applicator (Figures 19 and 20). Again the napier grass was almost totally killed after two wipings and Spanish needle became established (Figure 21).

Additional wiping and mowing were conducted and eventually Bermuda grass recovered (Figure 22) and spread over the area. The untreated control plot was covered with napier grass and Spanish needle (Figure 23). Desirable vegetation is usually present on the dike, but suppressed by the more dominant and aggressive undesirable napier grass. Once the aggressive undesirable vegetation is eliminated, other plant species present get an opportunity to grow. On the Herbert Hoover Dike system, the next plant species to overgrow the areas is Spanish needle. After it is controlled, the more desirable vegetation like Bermuda grass and Bahia grass recover and become dominant. It will take 3 to 4 years of wiper/mowing management to reverse the vegetation progression that has occurred over the past 10 or more years on the Herbert Hoover Dike. A combination of herbicide wiping and reduced fertilizer applications will return the dike system to more desirable vegetation that will be easier to manage. In addition to this weed control program, other technologies such as RSMT are being demonstrated and can improve the long-term fertility of the droughty dike dredged material/soil. The conversion to perennial peanut, which requires only potassium fertilizer and does not require mowing, will substantially reduce fertilizer and mowing costs for vegetative maintenance of this dredged material dike system.

Wilmington, NC. The Eagle Island CDF was totally covered with 3-m- (10-ft-) tall common reed (Figure 1). The aboveground stems and tops (3 m (10 ft) tall) were cut with a box blade and placed into piles for burning or composting. Because burning can contribute to poor air quality, composting

was sought to manage the plant tops. After 6 months, the compost was used as cellulose in a manufactured topsoil according to RSMT. On May 23, 2000, the new regrowth of the Phragmites was wiped with a wiper panel on two separate demonstration plots (each 6 by 30 m (20 by 100 ft)) with the glyphosate herbicide Round-Up® at a rate of 2.3×10^2 mℓ/ha (32 oz/acre) once (Figures 24-27) and then a second time after 4 days. Two similar size control (untreated) plots were established for comparison. The plant height was approximately 0.6 m (2 ft) high each time wiping was performed. Effects of the wiping were observed on 24 Jun 2000 (32 days) (Figures 28 and 29). On 5 Jul 2000 (44 days), some new regrowth was observed (Figures 30 and 31). A gallon of ready-to-use Round-Up® was applied by hand spray to spot-spray the green leaves present on each demonstration plot. The concentration of glyphosate was 0.96 percent as the isopropylamine salt. Observations (Figures 32 and 33) were made on 22 Jul 2000 (60 days after the initial wiping and 14 days after hand spot-spray application). Control plots that were not wiped with herbicide were covered with Phragmites and other undesirable weeds (Figures 34 and 35). It is expected that the roots/rhizomes of Phragmites in these plots will be dead allowing material from that area to be used for RSMT manufactured topsoil or other uses without the interferences caused by Phragmites.

CONCLUSIONS AND RECOMMENDATIONS: Based on the results of these demonstrations, the following procedures for controlling undesirable vegetation such as napier grass and Phragmites on dredged material are recommended:

- After mowing or cutting and removal of plant tops, allow undesirable vegetation to regrow to between 0.3 and 0.6 m (1 and 2 ft) tall.
- With wiping equipment set at 0.3 m (1 ft) above the surface of the ground, wipe plant tops with glyphosate (Round-Up®, Gly-flow or equivalent) at a rate of 2.3×10^2 mℓ/ha (32 oz/acre).
- Repeat this procedure after 2 weeks.
- After 3 weeks, mow vegetation at a height of 152-203 mm (6-8 in.).
- When undesirable vegetation grows to 0.6 m (2 ft) in height, set the wiping equipment at 0.3 m (1 ft) and rewipe as before.
- Repeat the wiping at 2 weeks.
- After 3 weeks, mow vegetation at a height of 152-203 mm (6-8 in.).
- When undesirable vegetation grows to 0.6 m (2 ft) in height, set the wiping equipment at 0.3 m (1 ft) and rewipe as before.
- Repeat the wiping at 2 weeks.
- After 3 weeks, mow vegetation at a height of 152-203 mm (6-8 in.).
- Spot-wipe as required when undesirable weeds grow to a height of 0.6 m (2 ft) above the desirable vegetation.

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Mr. Buddy Pollard, Grasslands Services, Inc.; and Mr. Scott Peoples, Mr. Franco DePasquale, Mr. Jim Hunter, and Mr. Roy Adams, representing the Weedbug Company. Field observations were made by Ms. Angie Charles, Natural Resource Assistant Manager, South Florida Field Office at Clewiston, FL.

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> Lee, C. R. (2000) " Implementation guidance for the control of undesirable vegetation on dredged material," *DOER Technical Notes Collection* (ERDC TN-DOER-C20), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/DOTS/DOER/*

Figure 1. Phragmites (*Phragmites communis*) covering Eagle Island CDF, Wilmington, NC

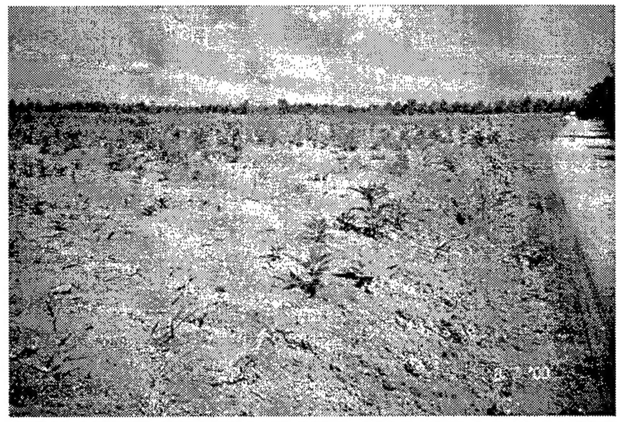

Figure 2. During dike raising at Eagle Island CDF, NC, undesirable vegetation established rapidly

Figure 3. Napier grass (*Pennisetum purpureum*) on the Herbert Hoover Dike around Lake Okeechobee, FL

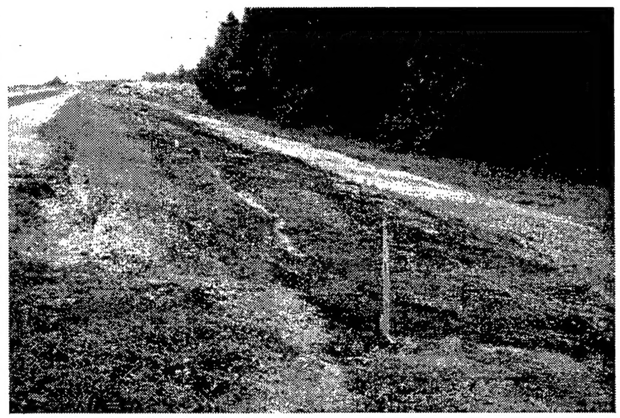

Figure 4. Incorporation of yardwaste and N-Viro biosolids into sandy, droughty dredged material on Herbert Hoover Dike (Jun 95)

Figure 5. Incorporation of bagasse and N-Viro biosolids into sandy, droughty dredged material on Herbert Hoover Dike (Jun 95)

Figure 6. Melaleuca compost applied to the Herbert Hoover dike dredged material and incorporated by disking

Figure 7. Lake debris harvested from Lake Okeechobee following hurricanes and piled on the shoreline of the Herbert Hoover dike

Figure 8. Lake debris in combination with N-Viro biosolids (left side of photo) and Bionsoil biosolids (right side of photo) incorporated by disking

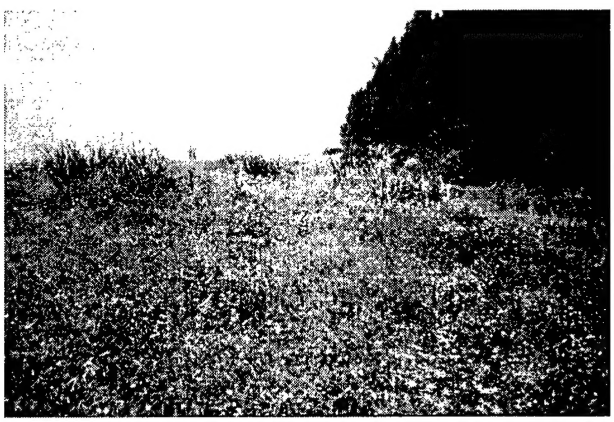

Figure 9. Massive native weed growth on the yardwaste and N-Viro biosolids demonstration plots (Jun 96)

Figure 10. Planted desirable vegetation established on the bagasse and N-Viro biosolids demonstration plots (Jun 96)

Figure 11. Vegetative cover on yardwaste and N-Viro biosolids demonstration plots (Sep 98)

Figure 12. Vegetative cover on bagasse and N-Viro biosolids demonstration plots (Sep 98)

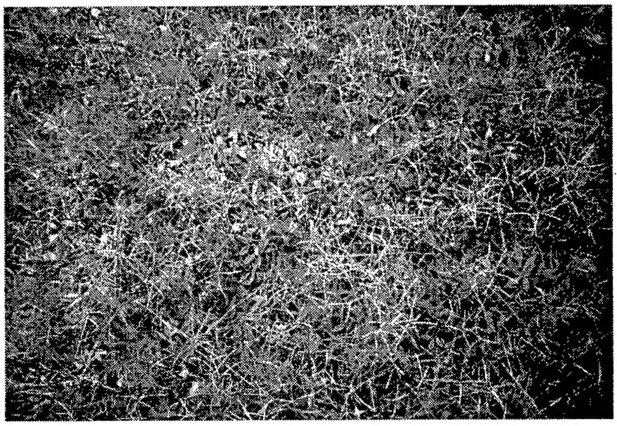

Figure 13. Perennial peanuts established with Bermuda grass on bagasse and N-Viro biosolids demonstration plots (Sep 98)

Figure 14. Herbicide wiping of undesirable vegetation on Herbert Hoover Dike dredged material at South Bay (Apr 96)

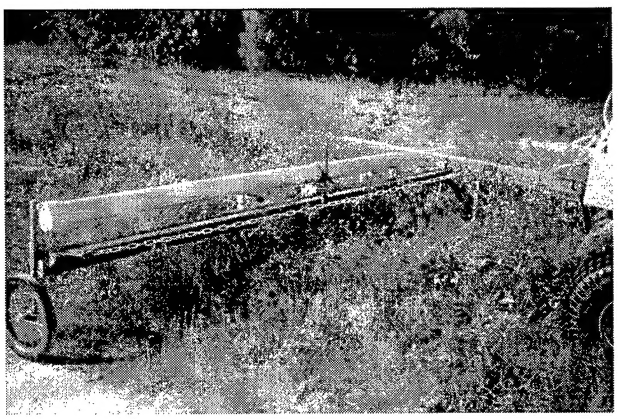

Figure 15. Wiper applicator set at 305 mm (12 in.) above ground to wipe herbicide on taller undesirable vegetation (Apr 96)

Figure 16. Less napier grass and more Spanish needle 1 month after wiping (May 96)

Figure 17. Untreated vegetation on right side of photo (May 96)

Figure 18. Elimination of napier grass, reduction of Spanish needle, and increased regrowth of Bermuda grass (Dec 99)

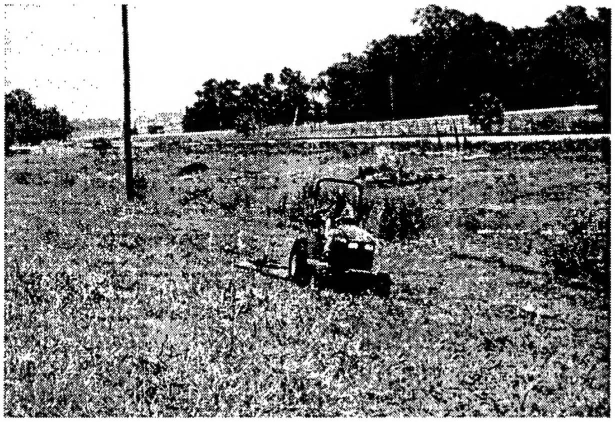

Figure 19. Wiping napier grass with the Weedbug® applicator (Apr 99)

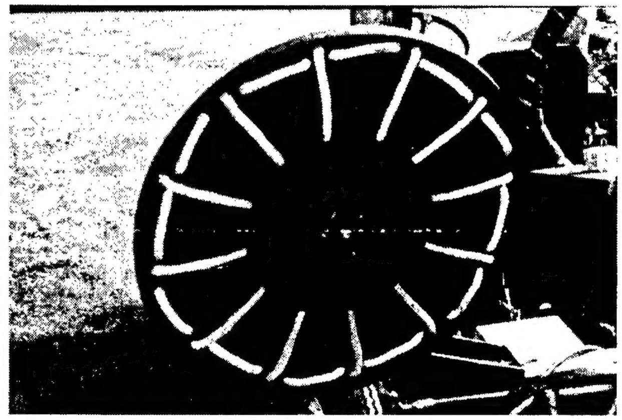

Figure 20. Closer view of Weedbug® applicator (Apr 99)

Figure 21. Napier grass eliminated, massive Spanish needle developed (Dec 99)

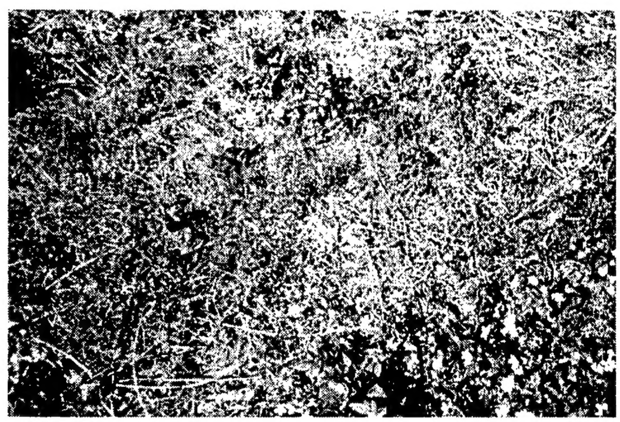

Figure 22. Bermuda grass regrowth among Spanish needle on herbicide-wiped plot (Dec 99)

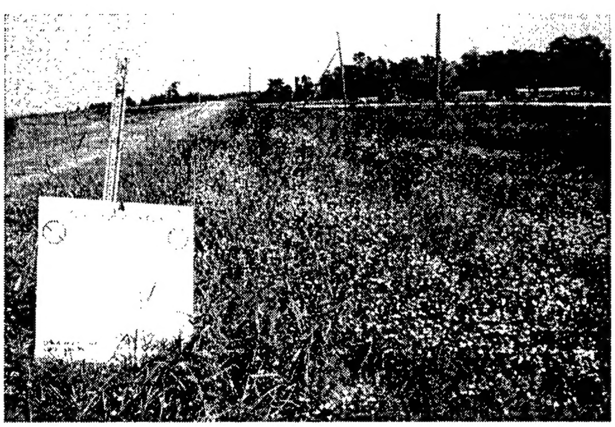

Figure 23. Control plot, no herbicide applied. Massive napier grass and Spanish needle developed (Dec 99)

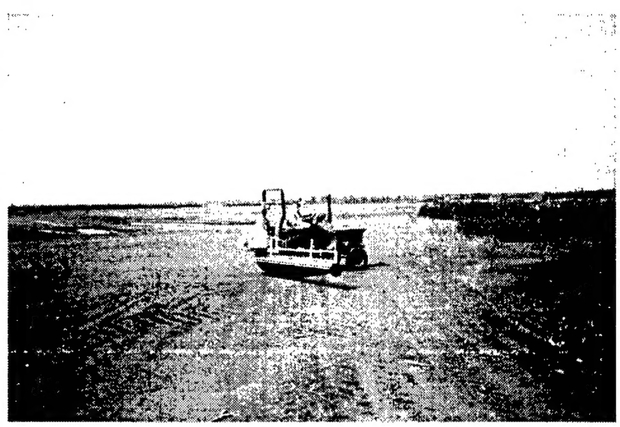

Figure 24. Modified wiper applicator on Eagle Island CDF, Wilmington, NC

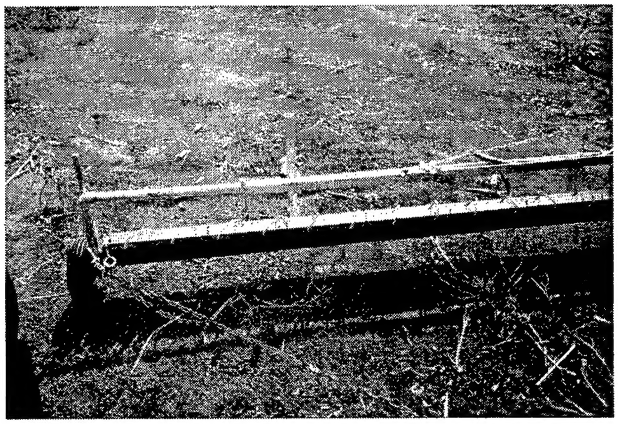

Figure 25. Close-up view of carpet wiper applicator

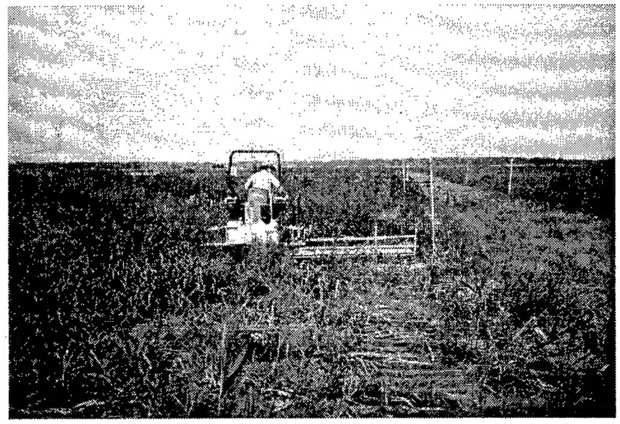

Figure 26. Wiper applying Round-Up® herbicide at a rate of 2.3×10^2 mℓ/ha (32 oz/acre) adjacent to Plot 1 at Eagle Island CDF, NC (23 May 00)

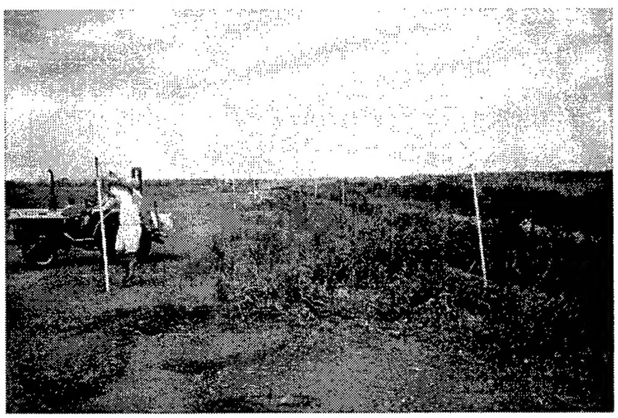

Figure 27. Wiper applying Round-Up® herbicide at a rate of 2.3×10^2 mℓ/ha (32 oz/acre) adjacent to Plot 2 at Eagle Island CDF, NC (23 May 00)

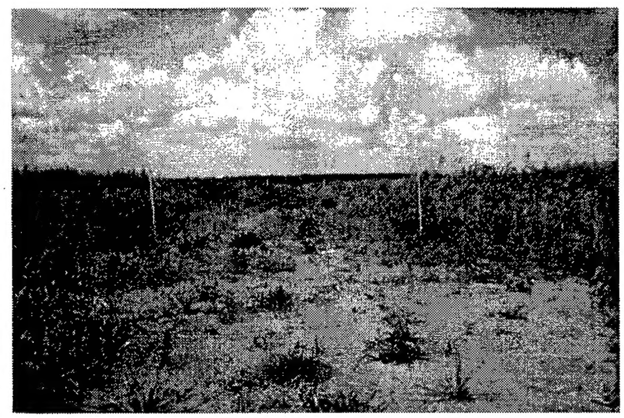

Figure 28. Observation at 32 days of the herbicide-wiped Plot 1 in the foreground with the unwiped control in the background (24 Jun 00)

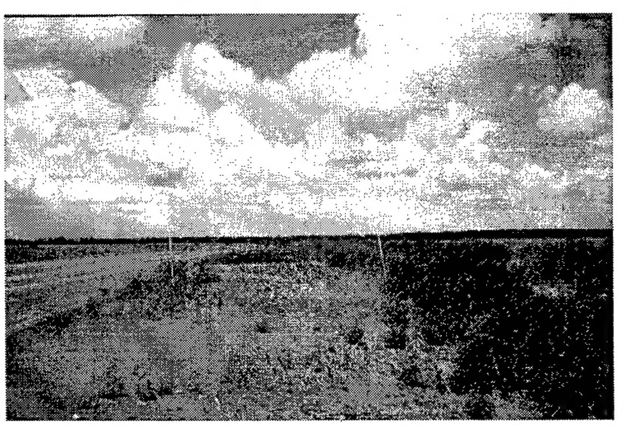

Figure 29. Observation at 32 days of the herbicide-wiped Plot 2 in the foreground with the unwiped control in the background (24 Jun 00)

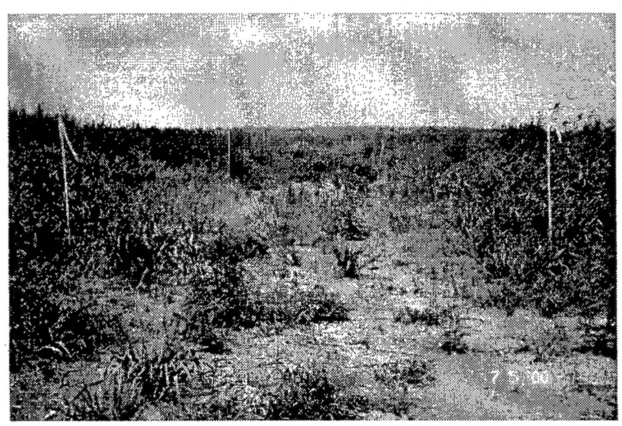

Figure 30. Observation at 43 days of the herbicide-wiped Plot 1 in the foreground with the unwiped control in the background (5 Jul 00)

Figure 31. Observation at 43 days of the herbicide-wiped Plot 2 in the foreground with the unwiped control in the background (5 Jul 00)

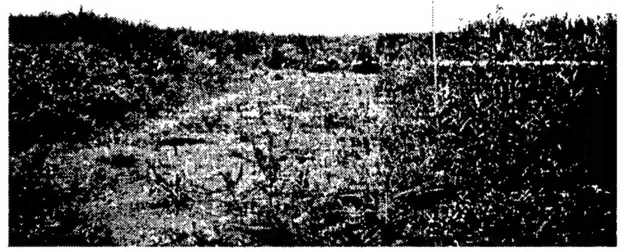

Figure 32. Observation at 60 days of the herbicide-wiped Plot 1 in the foreground with the unwiped control in the background (22 Jul 00)

Figure 33. Observation at 60 days of the herbicide-wiped Plot 2 in the foreground with the unwiped control in the background (22 Jul 00)

Figure 34. Plot 1 control, unwiped (Jul 00)

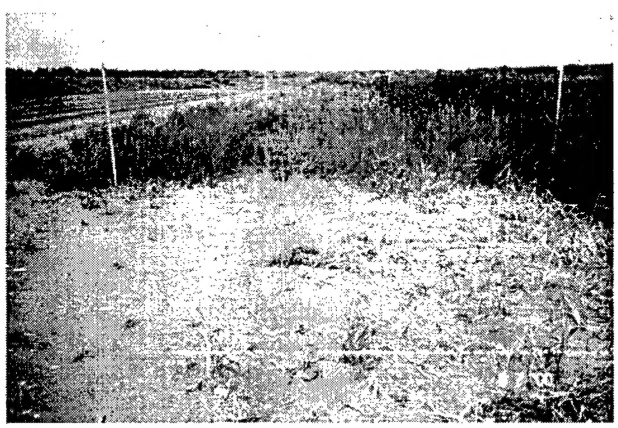

Figure 35. Plot 2 control, unwiped (Jul 00)

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